CLAIMS

1. An optical WDM network comprising at least two nodes interconnected by a bidirectional optical link, each node comprising

at least two pairs of ordinary optical transmitters and ordinary optical receivers, each pair including an ordinary optical transmitter receiving electrical signals and converting the received electrical signals to issued first optical signals and an ordinary optical receiver receiving optical signals and converting them to electrical signals, and

ordinary transponders, each ordinary transponder receiving the issued first optical signals from only one of the ordinary optical transmitters of the pairs and converting the received signals to issued second optical signals of a well defined wavelength band, the wavelength bands of the second optical signals issued by different ones of the ordinary transponders being separate from each other,

**characterized in** that each node further comprises a first optical multiplexer or combiner connected to receive the second optical signals issued by the ordinary transponders of the node, the first optical multiplexer or combiner combining the second optical signals to issue a combined optical signal on an optical fiber included in the bidirectional link interconnecting the node and another node. (Figs. 1 - 9)

2. A WDM network according to claim 1, **characterized in** that each node further comprises a spare transponder connected to receive, for a failure of an ordinary transponder of the node, the first optical signals, which are to be received by the ordinary transponder, and to convert the received first optical signals to issued third optical signals of a well defined wavelength band separate from the wavelength bands of the second optical signals issued by the ordinary transponders in the node, the spare transponder being connected to the first optical multiplexer or combiner of the node to provide the third optical signals to the first optical multiplexer or combiner which combines the third optical signals issued by the spare transponder of the node with the second optical signals issued by the ordinary transponders of the node to issue a combined optical signal on the optical fiber. (Figs. 2 - 9)

3. A WDM network according to claim 2, **characterized in** that each node further comprises first optical switches, each first optical switch having an input and a first output and a second output, the input of the first optical switch being connected to one of the ordinary optical transmitters of the node and the first output being connected to that ordinary transponder which is connected to receive the first optical signals issued by said one of the ordinary optical transmitters of the node to forward optical signals received on the input of the first optical switch to that ordinary transponder, and the second output being connected to the spare transponder to forward optical signals received on the input of the first optical switch to the spare transponder, depending on a position of the first optical switch. (Figs. 2, 3, 7, 8)

4. A WDM network according to claim 3, **characterized in** that each ordinary transponder in a node is provided with an input loss detector controlling that first optical

switch, the first output of which is connected to the ordinary transponder. (Figs. 2, 3, 7, 8)

5. A WDM network according to claim 2, **characterized in** that each node further comprises optical power splitters, each optical power splitter having an input and a first output and a second output, the input of the optical power splitter being connected to one of the ordinary optical transmitters of the node to receive signals issued by said one of the ordinary optical transmitters and the first output of the optical power splitter being connected to that ordinary transponder which is connected to receive the first optical signals issued by said one of the ordinary transmitters to forward a first share of the optical signals received on the input to that ordinary transponder, and the second output of the optical power splitter being connected to forward a second share of the optical signals received on the input to the spare transponder of the node. (Figs. 6, 9)

6. A WDM network according to ~~any of~~ claims 2 ~~- 5~~, **characterized in** that each node further comprises a second optical multiplexer or combiner having an output connected to an input of the spare transponder and having inputs connected to the ordinary optical transmitters of the node to receive the first optical signals issued by the ordinary optical transmitters and to forward the received first optical signals on the output of the second optical multiplexer or combiner to the spare transponder of the node. (Fig. 8)

7. A WDM network according to ~~any of~~ claims 2 ~~- 5~~, **characterized in** that each node further comprises a second optical switch having one output and a plurality of inputs, one input of the second optical switch being arranged for and connected to each ordinary transponder, and the output of the second optical switch being connected to the input of the spare transponder, the second optical switch being arranged to connect one of its inputs to its output in order to forward the first optical signals issued by one of the ordinary optical transmitters of the node to the spare transponder of the node. (Figs. 2 - 7, 9)

8. A WDM network comprising at least two nodes interconnected by a bidirectional optical link, each node comprising at least two pairs of ordinary transmitter devices and ordinary receiver devices, each pair comprising one ordinary transmitter device and one ordinary receiver device being arranged to transmit and receive optical signals respectively of only a fixed, individual or separate well defined wavelength band,

**characterized in** that each node further comprises

a pair of a spare transmitter device and a spare receiver device, the spare transmitter device and the spare receiver device being arranged to respectively transmit and receive optical signals of only a fixed well defined wavelength band different from the wavelength bands in which the ordinary transmitter devices and receiver devices of the node are arranged to transmit and receive respectively optical signals, and

a switch connected in such a way that if one of the ordinary transmitter devices of the node fails, an input signal of said one of the ordinary transmitter devices is connected through the switch to an input of the spare transmitter device. (Figs. 2 - 9)

9. ~~A WDM network according to claim 8,~~ **characterized in** that

the ordinary transmitter device of each pair of an ordinary transmitter device and an ordinary receiver device of a node comprises an ordinary optical transmitter and an ordinary transponder connected to the ordinary transmitter, the ordinary optical transmitter receiving electrical signals and converting the received electrical signals to issued first optical signals and the ordinary transponder receiving the first optical signals issued by the ordinary optical transmitter and converting the received first optical signals to issued second optical signals of the wavelength band, in which the ordinary transmitter device and the ordinary receiver device of the pair are arranged to transmit and receive optical signals respectively, and

the spare transmitter device of a pair of a spare transmitter device and a spare receiver device of a node comprises at least one spare transmitter and a spare transponder connected to the spare transmitter, the spare transponder being common to all spare transmitters of the node and connected to said all spare transmitters to convert received signals to issued third optical signals of the wavelength band, in which the spare transmitter device and the spare receiver device of the pair are arranged to transmit and receive optical signals respectively. (Figs. 2 - 7)

10. A WDM network according to claim 9, **characterized in** that the spare transponder of a spare transmitter device of a node is connected through a switch to all the ordinary optical transmitters in the node to receive the first optical signals issued by at most one of the ordinary optical transmitters of the node. (Figs. 2 - 7)

11. A WDM network according to ~~any of~~ claims 8 ~~- 10~~, **characterized in** that

the ordinary receiver device of each pair of an ordinary transmitter device and an ordinary receiver device of a node comprises a demultiplexer or filter and an ordinary optical receiver connected to the demultiplexer or filter, the ordinary optical receiver converting optical signals received from the demultiplexer or filter to electrical signals, the demultiplexer or filter being common to and connected to all the ordinary optical receiver devices in the node, and

the spare receiver device of the pair of a spare transmitter device and a spare receiver device of the node comprises the demultiplexer or filter, the ordinary optical receivers comprised in all the ordinary receiver devices of the node and a switching device, the switching device having outputs connected to the ordinary optical receivers to forward, at each instant, a signal from the demultiplexer or filter to at most one of the ordinary optical receivers. (Figs. 2 - 7)

12. A WDM network according to ~~any of~~ claims 8 ~~- 10~~, **characterized in** that

the ordinary receiver device of each pair of an ordinary transmitter device and an ordinary receiver device in a node comprises a demultiplexer or filter and an ordinary optical receiver connected to the demultiplexer or filter, the ordinary optical receiver converting optical signals received from the demultiplexer or filter to electrical signals, the demultiplexer or filter being common to and connected to all the ordinary optical receivers of the node, and

the spare receiver device of the pair of a spare transmitter device and a spare receiver

device of the node comprises the demultiplexer or filter, spare optical receivers converting received optical signals to electrical signals and a switching device, the spare optical receivers being connected to the demultiplexer or filter through the switching device, the switching device having an input connected to the demultiplexer or filter to receive optical signals from the demultiplexer or filter and outputs connected to the spare optical receivers to forward, at each instant, a signal from the demultiplexer or filter to at most one of the ordinary spare optical receivers. (Figs. 2 - 7)

13. A WDM network according to claim 12, **characterized in** that a signal which is forwarded from the demultiplexer or filter of a node to one of the spare optical receivers of the node is in the same wavelength band, in which the spare transmitter device and the spare receiver device of a pair in the node are arranged to transmit and receive optical signals respectively.

14. A WDM network according to claim 13, **characterized in** that a signal which is forwarded from the demultiplexer or filter of a node to one of the spare optical receivers of the node is in the same wavelength band as that of the ordinary transmitter device in the pair of an ordinary transmitter device and that ordinary receiver device which comprises an ordinary receiver with which the spare receiver is included in a pair.

15. A WDM network comprising at least two nodes interconnected by a bidirectional optical link, each node comprising at least two pairs of ordinary optical transmitters and ordinary optical receivers, each pair comprising an ordinary optical transmitter receiving electrical signals and converting the received electrical signals to optical signals and issuing the optical signals to another node and an ordinary optical receiver receiving optical signals from the other node and converting the received optical signals to electrical signals, **characterized in** that each node further comprises spare optical transmitters, one spare optical transmitter being arranged together with an ordinary optical transmitter in a pair, the spare optical transmitter and the ordinary optical transmitter of a pair receiving the same electrical signals and converting the received electrical signals to optical signals and the spare optical transmitter being arranged to issue the optical signals to the other node, if the ordinary optical transmitter fails. (Figs. 2 - 7)

16. A WDM network according to claim 15, **characterized in** that each node further comprises first optical switches, each first optical switch being connected to an ordinary optical transmitter and a spare optical transmitter of a pair to forward optical signals from only one of the ordinary optical transmitter and the spare optical transmitter. (Figs. 2, 3, 7)

17. A WDM network according to claim 16, **characterized in** that each first optical switch in a node is arranged to connect, in a first position, the ordinary optical transmitter to an ordinary transponder, the ordinary transponder converting received optical signals to issued optical signals of a well defined wavelength band, the wavelength bands of different ordinary transponders in a node being separate from each other, the optical signals issued by the ordinary transponders of one node being provided to an optical multiplexer or combiner

combining the optical signals to issue them on an optical fiber connected to another node, and to connect, in a second position of the first optical switch, an ordinary transmitter to a spare transponder, the spare transponder converting received optical signals to issued optical signals of a well defined wavelength band, the wavelength band of the spare transponder being separate from the wavelength bands of the ordinary transponders in the node, the optical signals issued by the spare transponder being provided to the optical multiplexer or combiner to be also issued on the optical fiber. (Figs. 2, 3, 7)

18. A WDM network according to claim 17, **characterized in** that in the first position of one of the first optical switches of a node the spare optical transmitter which is connected to said one of the first optical switches is connected through said one of the first optical switches to the spare transponder through a second switch, the second switch allowing optical signals from at most one spare optical transmitter to reach the spare transponder. (Figs. 2, 3, 7)

19. A WDM network according to claim 18, **characterized in** that in the second position of one of the first optical switches of a node the ordinary optical transmitter which is connected to said one of the first optical switched is connected through the first optical switch to the spare transponder through the second switch, the second switch allowing optical signals from at most one ordinary optical transmitter to reach the spare transponder. (Figs. 2, 3, 7)

20. A WDM network according to ~~any of~~ claims 17 ~~-19,~~ **characterized in** that in the second position of one of the first optical switches of a node the spare optical transmitter which is connected to said one of the first optical switches is connected to a respective ordinary transponder. (Figs. 2, 3, 7)

21. A WDM network according to ~~any of~~ claims 17 ~~-20,~~ **characterized in** that each ordinary optical transmitter of a node is connected to an ordinary transponder, one ordinary transponder being arranged for each ordinary optical transmitter, an ordinary transponder being arranged to convert received optical signals to issued optical signals of a well defined wavelength band, the wavelength bands of different ordinary transponders in a node being separate from each other, the optical signals issued by the ordinary transponders of one node being provided to an optical multiplexer or combiner combining the signals to issue them on an optical fiber connected to another node, and the spare optical transmitters being connected to a spare transponder, the spare transponder converting received optical signals to issued optical signals of a well defined wavelength band, the wavelength band of the spare transponder being separate from the wavelength bands of the ordinary transponders in the node, the optical signals issued by the spare transponder being provided to the optical multiplexer or combiner, the connection of the spare optical transmitters to the spare transponder being made in such a way that the spare transponder receives at most optical signals issued by at most one spare transmitter. (Figs. 2 - 7)

22. A WDM network according to ~~any of~~ claims 15 ~~-21~~, **characterized in** that all ordinary receivers of a node are connected to a single demultiplexer or filter and convert

received optical signals to electrical signals. (Figs. 2 - 7)

23. A WDM network according to ~~any of~~ claim~~s~~ 15 ~~- 21~~, **characterized in** that all ordinary receivers of a node are connected to a single demultiplexer or filter and convert received optical signals to electrical signals, a switch being provided to conduct an optical signal from the demultiplexer or filter to at most one of the ordinary receivers, this optical signal being in the same wavelength band as the optical signals issued by a spare transponder.

24. A WDM network according to ~~any of~~ claim~~s~~ 15 ~~- 23~~, **characterized in** that each node further comprises spare optical receivers, one spare optical receiver being arranged together with an ordinary optical receiver in a pair, the spare optical receiver and the ordinary optical receiver of a pair converting received optical signals to electrical signals and being connected to output electrical signals to the same output terminal, so that the spare optical receiver delivers electrical signals to the output terminal, node, if the ordinary optical receiver cannot deliver electrical signals. (Figs. 2 - 7)

25. A WDM network according to claim 24, **characterized in** that all ordinary receivers of a node are connected to a single demultiplexer or filter and convert received optical signals to electrical signals, each spare receiver being connected to the demultiplexer or filter through a switch, the switch having a plurality of outputs, each output being connected to a different one of the spare optical receivers, and the switch being arranged to forward a signal from the demultiplexer or filter to at most one of the spare optical receivers. (Figs. 2 - 7)

26. A WDM network according to claim 25, **characterized in** that a signal which is forwarded from the demultiplexer or filter to one of the spare optical receivers is in the same wavelength band as the optical signals issued by a spare transponder of the node.

27. A WDM network according to claim 25, **characterized in** that a signal which is forwarded from the demultiplexer or filter of a node to one of the spare optical receivers of the node is in the same wavelength band as the optical signals issued by the ordinary transmitter in the pair of an ordinary transmitter and that ordinary receiver, with which the spare receiver is included in a pair.

28. A node for connection to another node by a bidirectional optical link in an optical WDM network, the node comprising

at least two pairs of ordinary optical transmitters and ordinary optical receivers, each pair including an ordinary optical transmitter receiving electrical signals and converting the received electrical signals to issued first optical signals and an ordinary optical receiver receiving optical signals and converting them to electrical signals, and

ordinary transponders, each ordinary transponder receiving the issued first optical signals from only one of the ordinary optical transmitters of the pairs and converting the received signals to issued second optical signals of a well defined wavelength band, the wavelength bands of the second optical signals issued by different ones of the ordinary transponders being separate from each other,

characterized by a first optical multiplexer or combiner connected to receive the second optical signals issued by the ordinary transponders, the first optical multiplexer or combiner combining the second optical signals to issue a combined optical signal on an optical fiber included in a bidirectional link interconnecting the node and the other node. (Figs. 1 - 9)

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